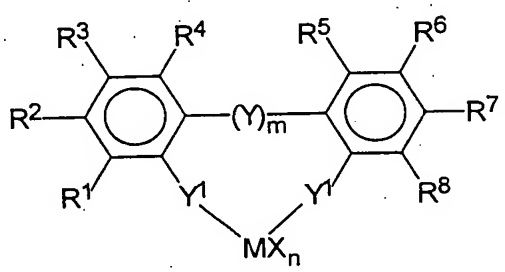
Claims:

1. A process for preparing partially hydrogenated, racemic ansa-metallocene complexes by reacting bridged or unbridged transition metal-aromatic complexes of the formula I



(I)

where the substituents and indices have the following meanings:

M is titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, tungsten or an element of transition group III of the Periodic Table and the lanthanides,

X are identical or different and are each fluorine, chlorine, bromine, iodine, hydrogen, C_1–C_{10}–alkyl, C_6–C_{15}–aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, $–OR^{10}$ or $–NR^{10}R^{11}$,

n is an integer from 1 to 4 and corresponds to the valence of M minus 2,

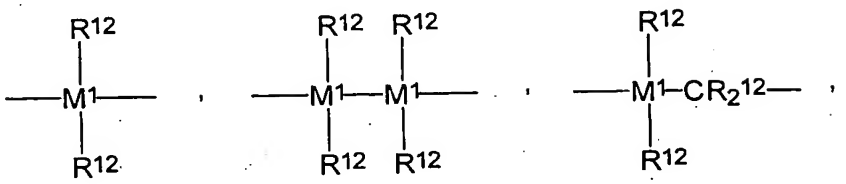
R^1 to R^8 are identical or different and are each hydrogen, halogen, C_1–C_{20}–alkyl, 3– to 8–membered cycloalkyl which may in turn bear a C_1–C_{10}–alkyl group as substituent, C_6–C_{15}–aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, arylalkyl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, where adjacent radicals from R^2 to R^7 may also form saturated, partially saturated or unsaturated cyclic groups having from 4 to 15 carbon atoms, $Si(R^9)_3$, $-OR^{10}$, $-SR^{10}$, $-N(R^{10})_2$, $-P(R^{10})_2$, and all the abovementioned radicals may be fully or partially substituted by heteroatoms,

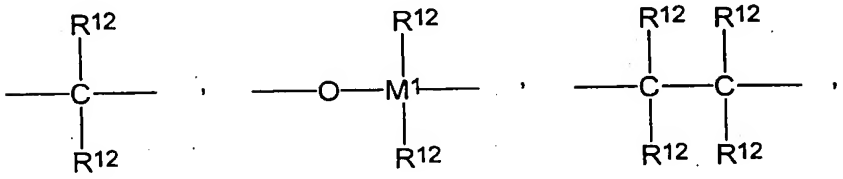
R^9 are identical or different and are each C_1–C_{20}–alkyl, C_3–C_{10}–cycloalkyl, C_6-C_{15}–aryl, where the radicals mentioned may be partially or fully substituted by heteroatoms,

R^{10} are identical or different and are each C_1-C_{10}-alkyl, C_6-C_{15}-aryl, C_3-C_{10}-cycloalkyl, alkylaryl or $Si(R^{11})_3$,

R^{11} are identical or different and are each C_1-C_{10}-alkyl, C_6-C_{15}-aryl, C_3-C_{10}-cycloalkyl, alkylaryl;

Y, Y^1 are identical or different and are each





or $=BR^{12}$, $=AlR^{12}$, –Ge–, –Sn–, –O–, –S–, =SO, $=SO_2$, $=NR^{12}$, =CO, $=PR^{12}$ or $=P(O)R^{12}$,

where

R^{12} are identical or different and are each hydrogen, halogen, C_1–C_{10}–alkyl, C_1–C_{10}–fluoroalkyl, C_6–C_{10}–fluoroaryl, C_6–C_{10}–aryl, C_1–C_{10}–alkoxy, C_2–C_{10}–alkenyl, C_7–C_{40}–arylalkyl, C_8–C_{40}–arylalkenyl, C_7–C_{40}–alkylaryl, or two radicals R^{12} together with the atoms connecting them form a ring,

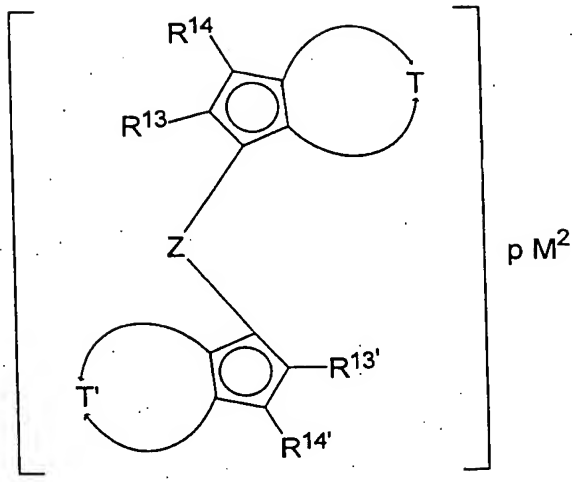
M^1 is silicon, germanium or tin and

m is 0, 1, 2 or 3, or

Y is nonbridging and represents two radicals R' and R" where

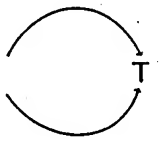
R', R" are as defined for R^1 to R^8 and R', R" together with adjacent radicals R^4, R^5 may also form saturated, partially saturated or unsaturated cyclic groups having from 4 to 15 carbon atoms,

with cyclopentadienyl derivatives of the formula II

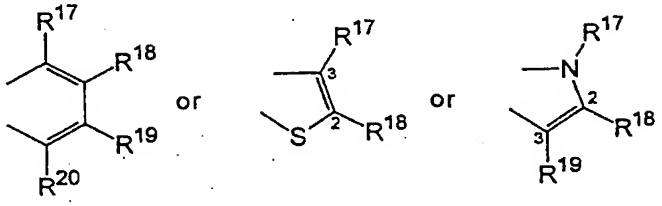


(II)

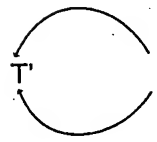
where



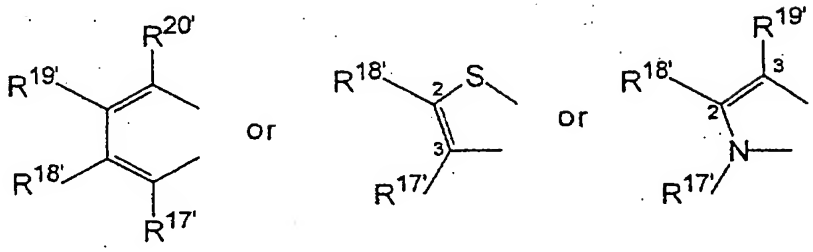
is a divalent group such as



and



is a divalent group such as



and the substituents and indices have the following meanings:

R^{13}, $R^{13'}$, R^{14}, $R^{14'}$ are identical or different and are each hydrogen, halogen, C_1–C_{20}–alkyl, 3– to 8–membered cycloalkyl which may in turn bear a C_1–C_{10}–alkyl group as substituent, C_6–C_{15}–aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, arylalkyl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, $-OR^{10}$, $-SR^{10}$, $-N(R^{10})_2$, $-P(R^{10})_2$ or $Si(R^9)_3$,

Z is a $-[Q(R^{15})(R^{16})]_q-$ group, where

Q may be identical or different and are each silicon, germanium, tin or carbon,

R^{15}, R^{16} are each hydrogen, C_1-C_{10}-alkyl, C_3-C_{10}-cycloalkyl or C_6-C_{15}-aryl, and

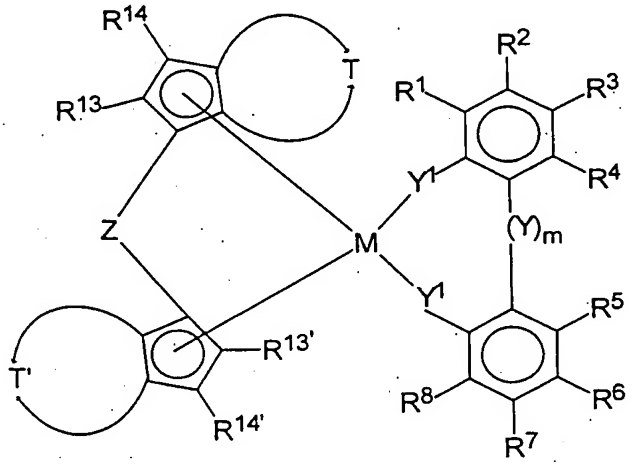
q is 1, 2, 3 or 4;

R^{17}-R^{20}, $R^{17'}$-$R^{20'}$ are identical or different and are each hydrogen, C_1-C_{20}-alkyl, 3-to 8-membered cycloalkyl which may in turn bear a C_1-C_{10}-alkyl group as substituent, C_6-C_{15}-aryl or arylalkyl, where adjacent radicals may together form cyclic groups having from 4 to 15 carbon atoms, or $Si(R^{11})_3$, and

M^2 is an alkali metal ion or alkaline earth metal ion, and

p is 1 when M^2 is an alkaline earth metal ion and is 2 when M^2 is an alkali metal ion;

and heating the resulting reacton mixture to a temperature in the range from minus 78°C to 250°C, with or without addition of free radicals or free radical formers, to give a complex of the formula III



(III)

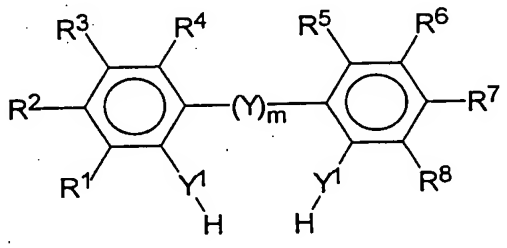
and at least partially hydrogenating III by means of hydrogen in the presence of a suitable catalyst.

2. A process as claimed in claim 1,
wherein, subsequent to the hydrogenation, the bridged phenoxide-analogous ligand or at least one of the two unbridged phenoxide-analogous ligands is/are replaced.

3. A process as claimed in claim 1 or 2,
wherein Y^1 are identical and are each oxygen.

4. A process as claimed in any of claims 1 to 3,
wherein the hydrogenation is carried out in the presence of homogeneous or heterogeneous catalysts such as Pt, Pd, Rh, Ru, Os or nickel, Raney nickel, their oxides, salts or complexes, mixtures thereof, if desired on suitable catalyst supports, particularly preferably in the presence of Pd on activated carbon.

5. A process as claimed in any of claims 1 to 4,
wherein the complex of the formula I is firstly prepared by deprotonation of compounds of the formula IV



(IV)
and subsequent reaction of the deprotonated compound(s) with a suitable transition metal compound of the formula V

$$MX_4(\text{Lewis base})_k \qquad (V)$$

where all radicals are as defined in claim 1 and k is 0, 1 or 2, and the complex of the formula I prepared in this way is converted in the reaction solution without isolation of intermediates into the complex of the formula IV.

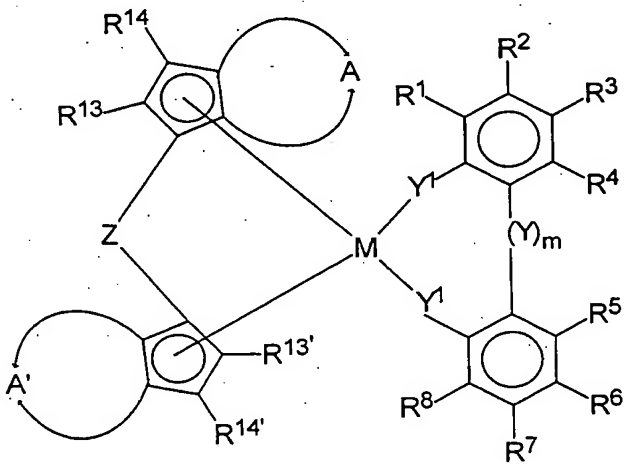
6. A process for preparing ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium bis(2,4,6-trimethylphenoxide) as set forth in claim 1,
wherein a dihalozirconium bis(2,4,6-trimethylphenoxide) compound is reacted with ethane-1,2-diylbisindenyldilithium to form ethanediylbis(indenyl)zirconium bis(2,4,6-trimethylphenoxide) which is subsequently hydrogenated to ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium bis(2,4,6-trimethylphenoxide).

7. A process for preparing ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium bis(2,4-di-tert-butylphenoxide) as set forth in claim 1,
wherein a dihalozirconium bis(2,4-di-tert-butylphenoxide) compound is reacted with ethane-1,2-diylbisindenyldilithium to form ethanediylbis(indenyl)zirconium bis(2,4-di-tert-butylphenoxide) which is subsequently hydrogenated to ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium bis(2,4-di-tert-butylphenoxide).

8. A process for preparing ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium dichloride as set forth in any of claims 2-5,
wherein a dihalozirconium bis(2,4,6-trimethylphenoxide) compound is reacted with ethane-1,2-diylbisindenyldilithium to form ethanediylbis(indenyl)zirconium bis(2,4,6-trimethylphenoxide) which is subsequently hydrogenated to ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium bis(2,4,6-trimethylphenoxide) and the phenoxide groups are subsequently replaced.

9. A process for preparing ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium dichloride as set forth in any of claims 2-5,
wherein a dihalozirconium bis(2,4-di-tert-butylphenoxide) compound is reacted with ethane-1,2-diylbisindenyldilithium to form ethanediylbis(indenyl)zirconium bis(2,4-di-tert-butylphenoxide) which is subsequently hydrogenated to ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium bis(2,4-di-tert-butylphenoxide) and the phenoxide groups are subsequently replaced.

10. A racemic ansa-metallocene complex of the formula VI:



(VI)

where the substituents and indices have the following meanings:

M is titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, tungsten or an element of transition group III of the Periodic Table and the lanthanides,

X are identical or different and are each fluorine, chlorine, bromine, iodine, hydrogen, C_1–C_{10}–alkyl, C_6–C_{15}–aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, $–OR^{10}$ or $–NR^{10}R^{11}$,

n is an integer from 1 to 4 and corresponds to the valence of M minus 2,

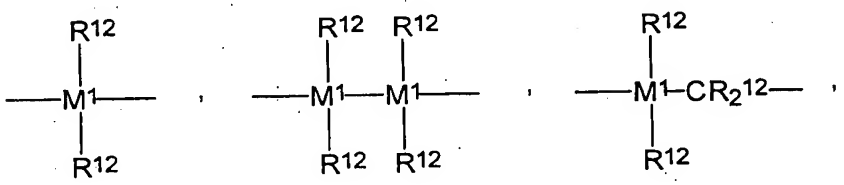
R^1 to R^8 are identical or different and are each hydrogen, halogen, C_1–C_{20}–alkyl, 3– to 8–membered cycloalkyl which may in turn bear a C_1–C_{10}–alkyl group as substituent, C_6–C_{15}–aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, arylalkyl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, where adjacent radicals from R^2 to R^7 may also form saturated, partially saturated or unsaturated cyclic groups having from 5 to 15 carbon atoms, $Si(R^9)_3$, $-OR^{10}$, $-SR^{10}$, $-N(R^{10})_2$, $-P(R^{10})_2$, and all the abovementioned radicals may be fully or partially substituted by heteroatoms,

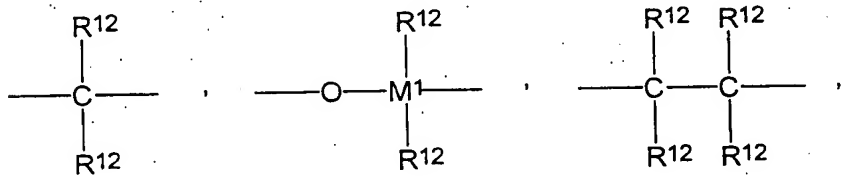
R^9 are identical or different and are each C_1–C_{20}–alkyl, C_3–C_{10}–cycloalkyl, C_6-C_{15}–aryl, where the radicals mentioned may be partially or fully substituted by heteroatoms,

R^{10} are identical or different and are each C_1-C_{10}-alkyl, C_6-C_{15}-aryl, C_3-C_{10}-cycloalkyl, alkylaryl or $Si(R^{11})_3$,

R^{11} are identical or different and are each C_1-C_{10}-alkyl, C_6-C_{15}-aryl, C_3-C_{10}-cycloalkyl, alkylaryl;

Y, Y^1 are identical or different and are each





or $=BR^{12}$, $=AlR^{12}$, –Ge–, –Sn–, –O–, –S–, =SO, $=SO_2$, $=NR^{12}$, =CO, $=PR^{12}$ or $=P(O)R^{12}$,

where

R^{12} are identical or different and are each hydrogen, halogen, C_1–C_{10}–alkyl, C_1–C_{10}–fluoroalkyl, C_6–C_{10}–fluoroaryl, C_6–C_{10}–aryl, C_1–C_{10}–alkoxy, C_2–C_{10}–alkenyl, C_7–C_{40}–arylalkyl, C_8–C_{40}–arylalkenyl, C_7–C_{40}–alkylaryl, or two radicals R^{12} together with the atoms connecting them form a ring,

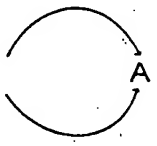
M^1 is silicon, germanium or tin and

m is 0, 1, 2 or 3, or

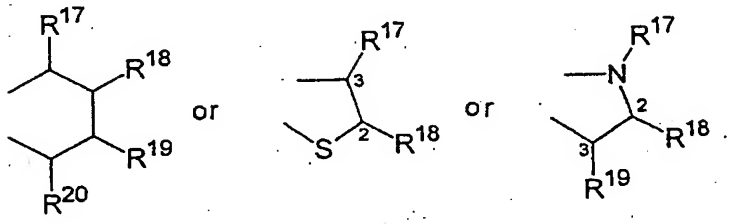
Y is nonbridging and represents two radicals R' and R'', where

R', R'' are as defined for R^1 to R^8 and R', R'' together with adjacent radicals R^4, R^5 may also form saturated, partially saturated or unsaturated cyclic groups having from 4 to 15 carbon atoms,

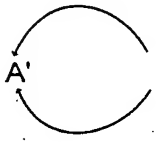
where



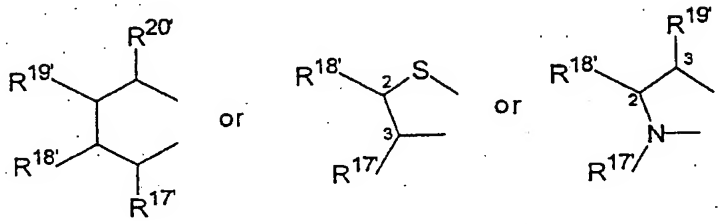
is a divalent group such as



and



is a divalent group such as



and the substituents and indices have the following meanings

R^{13}, $R^{13'}$, R^{14}, $R^{14'}$ are identical or different and are each hydrogen, halogen, C_1-C_{20}–alkyl, 3– to 8–membered cycloalkyl which may in turn bear a C_1-C_{10}-alkyl group as substituent, C_6–C_{15}–aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, arylalkyl having from 1 to 10 carbon atoms in the alkyl part and from 6 to 20 carbon atoms in the aryl part, $-OR^{10}$, $-SR^{10}$, $-N(R^{10})_2$, $-P(R^{10})_2$ or $Si(R^9)_3$, and

Z is a $-[Q(R^{15})(R^{16})]_q-$ group, where

Q can be identical or different and is silicon, germanium, tin or carbon,

R^{15}, R^{16} are each hydrogen, C_1-C_{10}-alkyl, C_3-C_{10}-cycloalkyl or C_6-C_{15}-aryl, and

q is 1, 2, 3 or 4;

R^{17}-R^{20}, $R^{17'}$-$R^{20'}$ are identical or different and are each hydrogen, C_1-C_{20}-alkyl, 3- to 8-membered cycloalkyl which may in turn bear a C_1-C_{10}-alkyl group as substituent, C_6-C_{15}-aryl or arylalkyl, where adjacent radicals may also together form cyclic groups having from 4 to 15 carbon atoms, or $Si(R^{11})_3$.

11. A metallocene complex as claimed in claim 8 selected from among ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium difluoride, ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium dichloride, ethanediylbis(4,5,6,7-tetrahydroindenyl)zirconium dibromide, rac-ethanediylbis(2-methyl-4,5,6,7-tetrahydroindenyl)zirconium dichloride and rac-ethanediylbis(2-ethyl-4,5,6,7-tetrahydroindenyl)zirconium dichloride.

12. The use of a racemic metallocene complex as claimed in claim 8 or 9 as a catalyst or as a constituent of a catalyst for the polymerization of olefinically unsaturated compounds or as a reagent or catalyst in stereoselective synthesis.